INA282-INA286EVM

This user's guide describes the characteristics, operation, and use of the INA282-286EVM evaluation module (EVM). This EVM is designed to evaluate the performance of the INA282-286 family of voltage output current shunt monitors. This EVM has a flexible configuration, allowing for user evaluation suitable to a variety of applications. This document also includes a schematic and a complete bill of materials.

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1 Introduction and Overview

1.1 INA282-286

The INA282-286 devices are voltage output, high-side measurement, bi-directional, zero-drift current shunt monitors. This family of devices has gains that range from 50V/V to 1000V/V. The voltage developed across the device inputs is amplified by the corresponding gain of the specific device and is presented at the output pin. The INA282-286 devices can sense voltage drops across shunts at common-mode voltages between –14V to 80V, independent of supply voltages. These devices operate with supply voltages between 2.7V and 18V and draw a maximum of 900µA. The low offset of the zero-drift architecture enables current sensing with maximum drops across the shunt as low as 10mV full-scale.

The INA282-286 devices are currently available in an SOIC-8 surface-mount package. Table 1 summarizes the available device options.

Table 1. INA282-286 Device Summary

Product	Gain
INA282	50
INA283	200
INA284	500
INA285	1000
INA286	100

1.2 INA282-286EVM

The INA282-286EVM is intended to provide basic functional evaluation of this device family. The fixture layout is not intended to be a model for the target circuit, nor is it laid out for electromagnetic compatibility (EMC) testing.

The layout of the INA282-286EVM printed circuit board (PCB) is designed to provide these features:

- Easy handling of the small package; a mechanical drawing of the recommended land pattern is found at the end of the product data sheet.
- Easy access to all pins of the device
- Space for optional input filtering capacitors and resistors as well as a prototype area for additional user-defined circuitry
- Space for shunt resistors of various footprints
- Multiple input signal options
- Evaluation of all gain options through provided device boards as well as a location to solder a test device directly on to the board

The INA282-286EVM allows the user to install a shunt resistor, and then connect both the common-mode voltage and load to develop the input voltage, or to omit the shunt resistor and apply a differential voltage directly to the device input. This flexibility allows a user to test the device operation in a simulated manner as well as in an actual application.

Refer to the INA282-286 product data sheet for comprehensive information about the INA282-286 family of devices.

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1.3 Hardware Included

The INA282-286EVM features the SOIC-packaged version of the INA28x. Device boards populated with each of the available gain versions of the INA282 family of devices will be provided in all INA282-286EVM delivered, as Figure 1 shows.

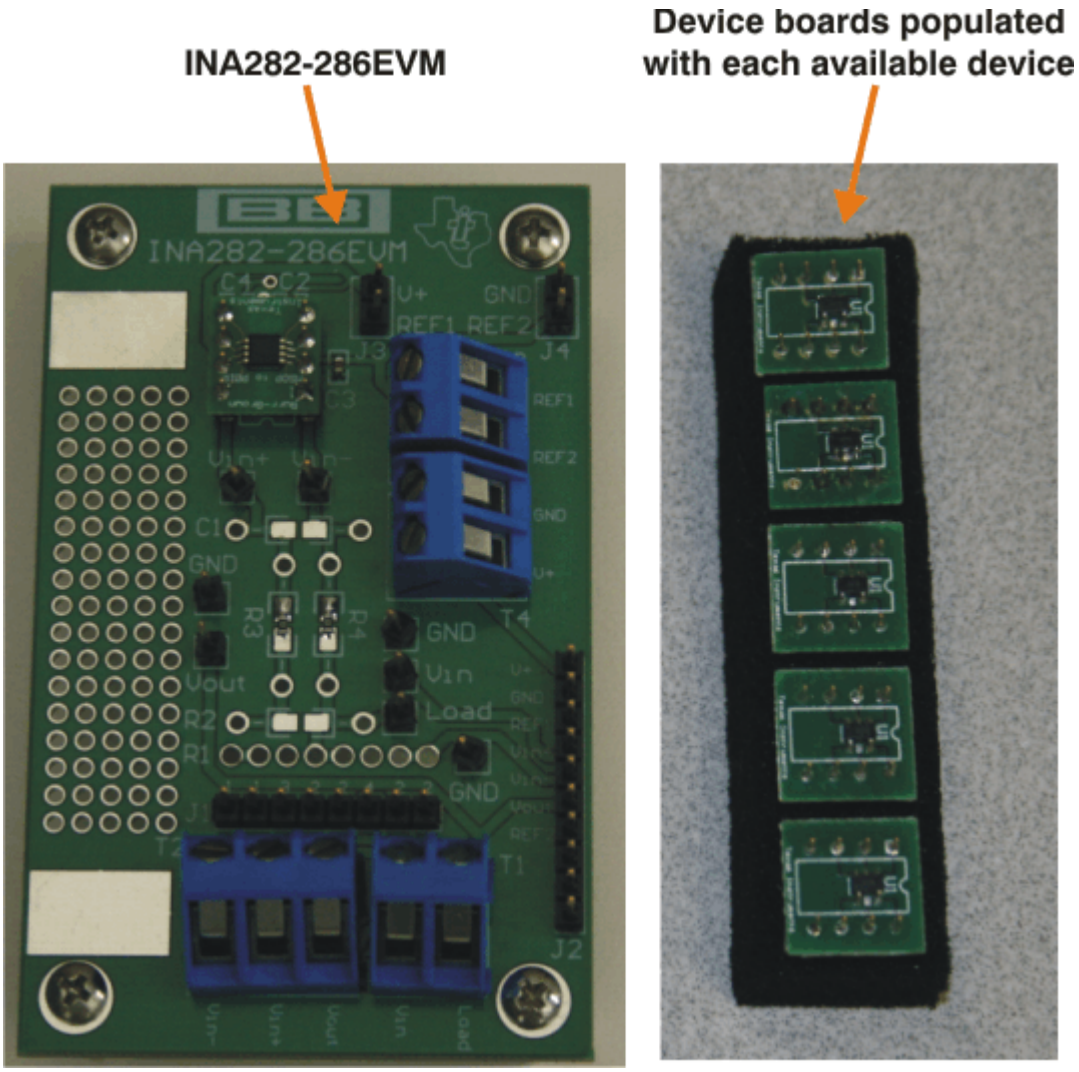

Figure 1. Hardware Included with the INA282-286EVM

The INA282-286EVM kit is shipped with the following items:

- INA282-286EVM PCB
- Five populated test boards (INA282, INA283, INA284, INA285, INA286)

If any of the items in the EVM kit shipment are missing or damaged, please contact the Texas Instruments Product Information Center nearest you to inquire about a replacement.

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2 Quick Start Setup and Use

Follow these procedures to set up and use the INA282-286EVM.

Step 1. Insert the device board to be evaluated into the U1 location. The U1 location allows the user to either evaluate one of the provided device boards or to install the test device directly on the surface-mount pads in the U1 footprint.

Step 2. Connect an external dc supply voltage between 2.7V and 18V to the V+ terminal referenced to the GND terminal of T4. The INA282-286 device output voltage is limited to 40mV above ground to 400mV below the supply level.

Step 3. The default connection for the references is to have the jumper in place on J3 and J4. This configuration allows for bi-directional operation with the output referenced to mid-supply. The voltage applied at the reference input can be varied depending on how the device is to be used. Further details regarding the use of the reference voltage are discussed later in this guide; refer to Section 4 for additional information on configuring the reference pins based on the user's application requirements.

Step 4. Connect the Input.

2.1 Measurement With Shunt

This connection method allows the user to install a shunt resistor on the evaluation board and connect the common-mode voltage and load to incorporate the test device directly into a sample application, as Figure 2 illustrates. To configure a measurement evaluation with a shunt, follow these procedures.

1. Install shunt resistor into the R2 location. If not using a surface-mount or through-hole shunt, refer to Section 3.1 for a summary of the R1 component specifications.
2. Connect the common-mode voltage to the V_{IN} terminal of T1.
3. Connect load to the Load terminal of T1.

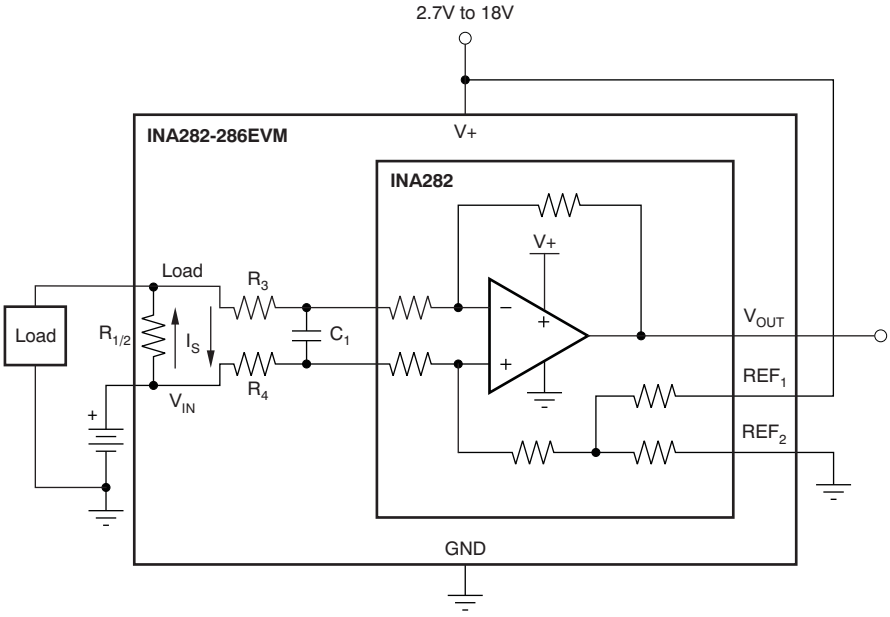

Figure 2. Measurement with Shunt

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2.2 Measurement Without Shunt

This connection method allows the user to either simulate the voltage developed across a sense resistor based on a given set of system conditions, or to connect the INA282-286EVM remotely to an existing shunt already included in an example application. Figure 3 illustrates a measurement configuration without a shunt. As a result of the internal architecture of the INA282 family of devices, if this measurement method is used, make sure the voltage source is either a very low impedance or the differential voltage applied to the inputs is buffered to prevent additional errors in the circuit.

To configure a measurement evaluation without a shunt, follow these procedures.

1. Connect a differential voltage to the V_{IN+} and V_{IN-} terminals of T2.
2. Measure the output voltage at the V_{OUT} terminal of T2.

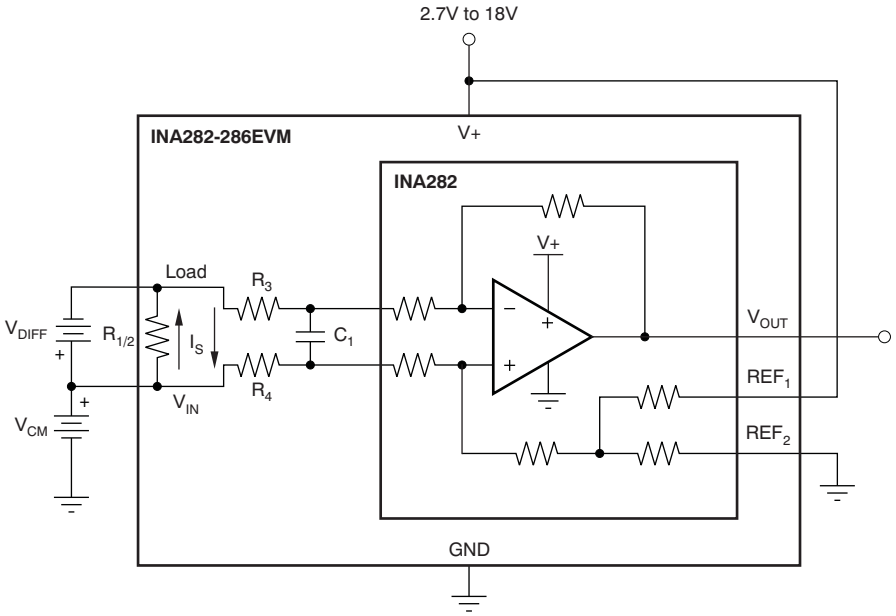

Figure 3. Measurement without Shunt

NOTE: The output voltage is equal to the reference voltage plus the gain of the device multiplied by the differential voltage measured directly at the device input pins.

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3 INA282-286EVM Circuit

This section summarizes the INA282-286EVM components.

3.1 R1

R1 can be used for shunt resistors that have a package that is not easily adaptable to a standard, two-terminal, through-hole footprint or to a 0603 through 1206 surface-mount footprint. Specifically, this component location was added to allow for the use of TO-126, TO-220, TO-247, and four-terminal inline radial packages such as the CS3 series of shunts from Ohmite. The numbers located on the PCB between R1 and J1 correspond to each of the holes in the R1 footprint. Holes with the same number are connected together. The designation of *1* and *2* indicates that particular hole is connected directly to the V_{IN+} and V_{IN-} inputs, respectively. The designation of *3* and *4* indicates that particular hole is intended for the sense measurement of a four-wire shunt.

Care must be taken to ensure that the shunt is placed in the correct position in the R1 location. This placement consideration is evident when using a two-connection shunt with a spacing of 200 mils (.200in or 5,080mm). As shown in Figure 4 through Figure 7, the shunt must be placed in the second *1*-designated hole in order for the other leg to fit into the *2* position. If the shunt is placed in the first *1* position, the second leg is left floating; no differential voltage is then generated for the current monitor.

Additional packages can be tested by using the provided prototype area of the board.

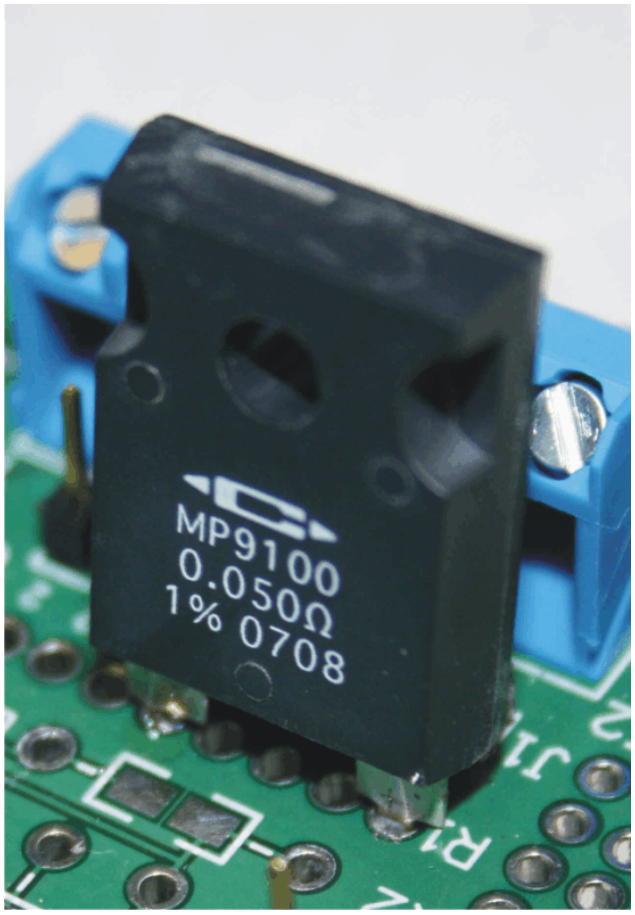

Figure 4. TO-247 Package in R1

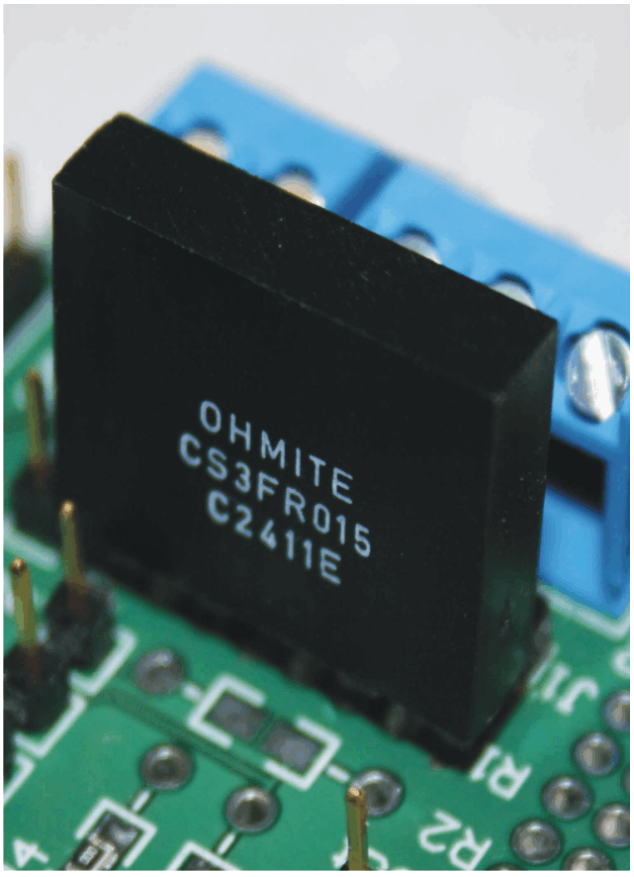

Figure 5. CS3 Package in R1

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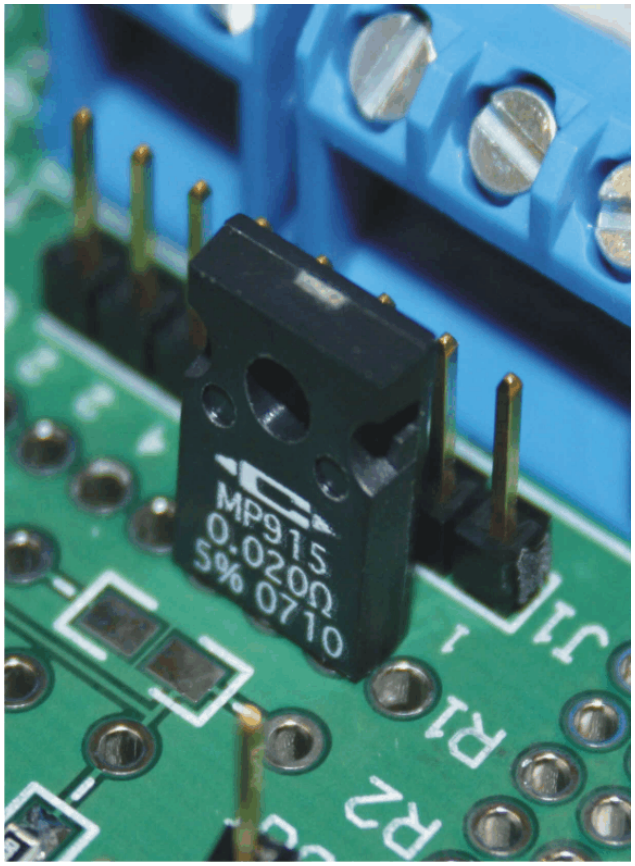

Figure 6. TO-126 Package in R1

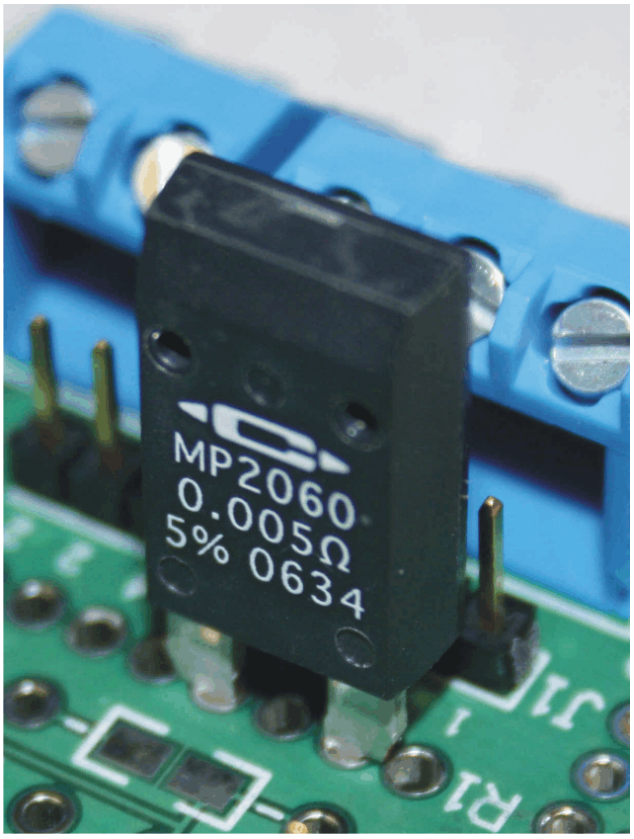

Figure 7. TO-220 Package in R1

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3.2 R2

R2 is intended to handle two- and four-terminal radial packages (as Figure 8 illustrates) as well as surface-mount packages that range in size from 0603 to 1206.

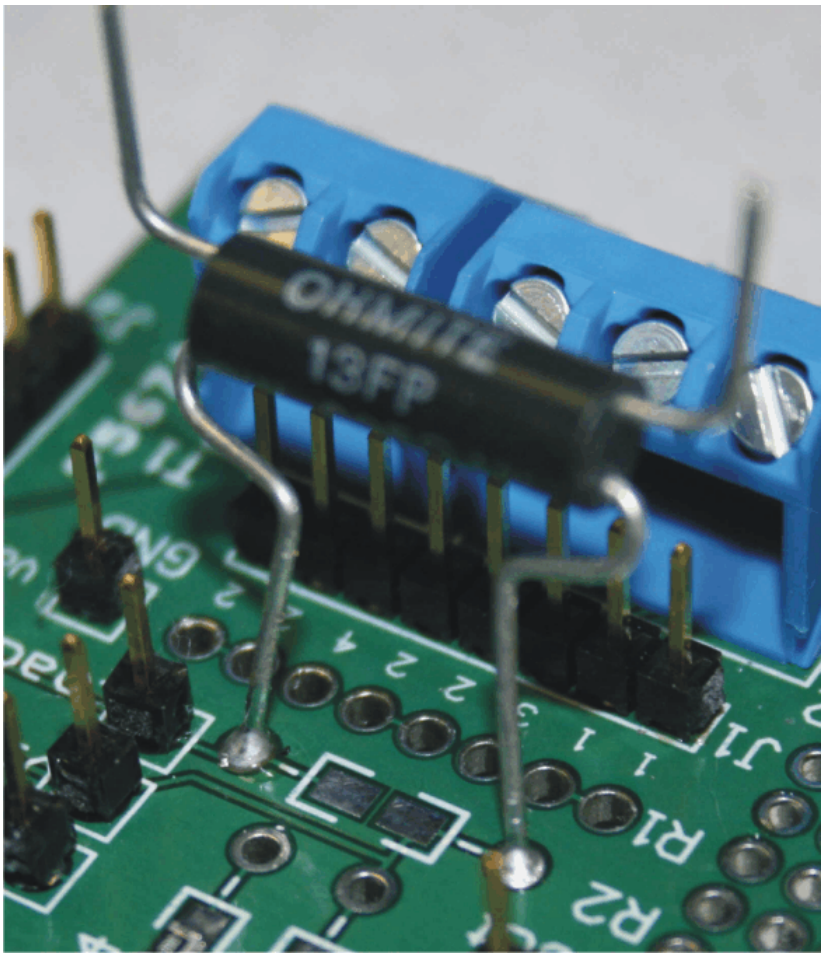

Figure 8. Radial Package in R2

3.3 R3, R4, C1

R3 and R4 are factory-installed 0Ω resistors. These resistors, in combination with C1, form an input filter. These locations allow for through-hole and surface-mount packages that range in size from 0603 to 1206. Additional information regarding the use of input filtering is provided in the INA282-286 product data sheet.

3.4 Bypass Capacitors and Jumpers

C2, C3, and C4 are 0.1μF supply bypass capacitors.

J1 is intended to be used as measurements points of R1, if necessary.

J2 is used as a test port at the factory but can be used for the corresponding input and output pins, if desired.

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3.5 U1

U1 is the location for the test device. Five device boards are supplied with this INA282-286EVM board; each device board is populated with one of the available device gains. This interchangeable option allow users to test the devices and determine the gain setting that is best suited for a given application.

Here is a list of the factors involved in selecting the appropriate device.

- The INA282-286 devices are identical with the exception of different gain settings.
- The limiting factor that requires attention to be given to device selection is the output voltage.
- The output voltage has a restriction: it must remain within the range of 40mV above ground to 400mV below the supply voltage.
- The differential input voltage is either applied across the inputs, or developed based on the load current flowing through the shunt resistor.
- The selected device must allow the output voltage to remain within the acceptable range after the developed input voltage is amplified by the respective device gain.
- An output below the minimum allowable output requires the selection of a device with a higher gain. Likewise, an output above the maximum allowable output requires the selection of a device with a smaller gain.

In addition to being able to accommodate the device boards, a surface-mount footprint has been added as well. This footprint, though, is for an MSOP package that will be available at a later date. This option will allow a device to be installed directly onto the EVM if needed. Figure 9 shows the U1 slot populated with a DIP board device as an example.

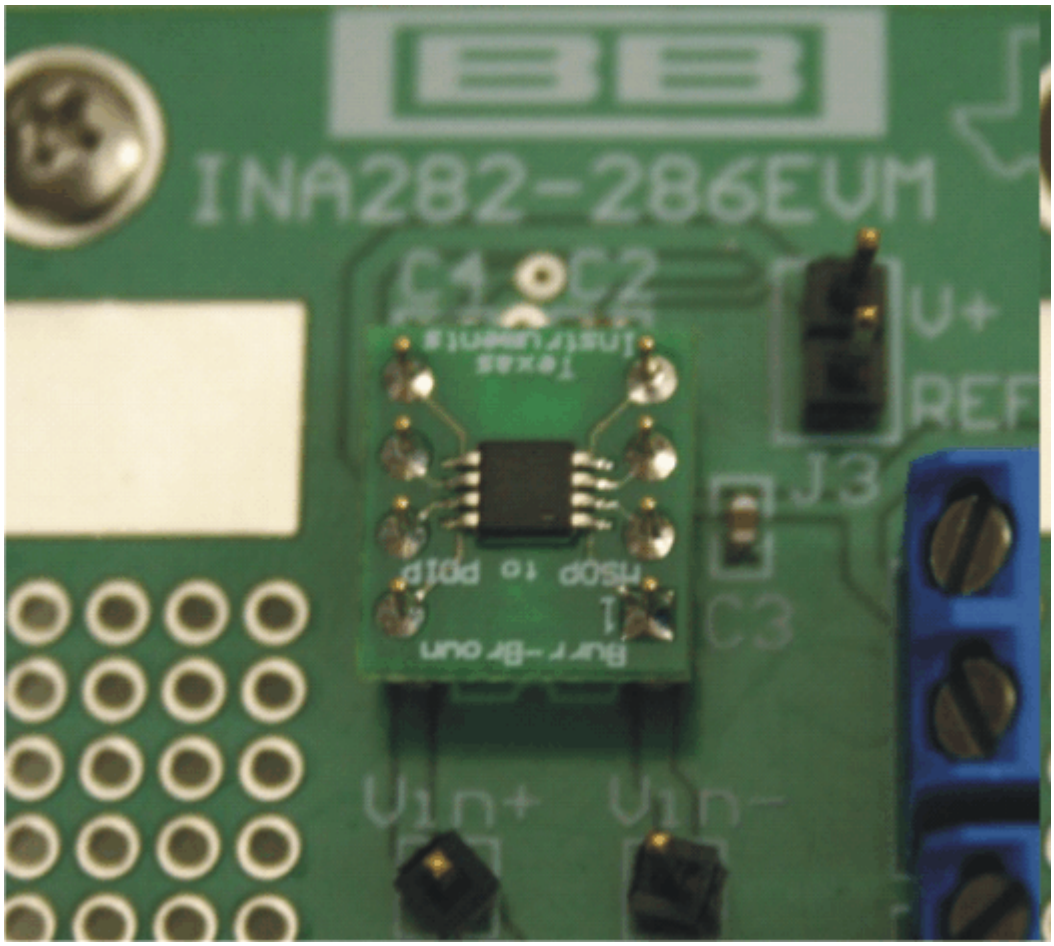

Figure 9. U1 Populated With DIP Board

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3.6 Voltage Inputs

The V_{IN+} and $V_{IN–}$ terminals of T2 are intended to be used if the designer is configuring this EVM for measurement without an onboard shunt resistor (see Figure 3). These inputs accept a differential voltage that is amplified by the selected device gain and is presented at the V_{OUT} terminal of T2. These inputs could also be used to connect the differential voltage developed across an external shunt in an existing circuit. The acceptable differential input voltage range and polarity are determined by the supply voltage, reference voltage, and gain of the selected device.

The V_{IN} and Load terminals of T1 are intended to be used if the user configures this EVM for measurement with a shunt resistor, as shown in Figure 2. The common-mode voltage should be connected to the V_{IN} terminal and the load should be connected to the Load terminal. The shunt can be installed in R1, R2, or the prototype area, and wired to the R2 footprint. As in the setup for the measurement without a shunt resistor, the input voltage range and polarity are determined by the supply voltage and the reference voltage, and the gain of the selected device.

3.7 Miscellaneous

The REF1 and REF2 terminals of T3 allow the user to configure the INA282-286EVM for either unidirectional or bi-directional operation.

Two easily-accessed oscilloscope ground pads are located on the PCB to facilitate easier probing.

4 Reference Voltage Setup

The INA282-286 devices allow an external voltage signal to be used for the device's reference voltage. This reference voltage determines how the output responds to certain input conditions. The configurable settings of the reference allow these devices to be used in both unidirectional and bi-directional applications.

4.1 Unidirectional Mode

Unidirectional refers to a load current that flows in only one direction. For unidirectional applications, the reference voltage can be set to ground or to +5V. If the reference is set to ground, the output is set at near ground with no input voltage, and responds to input voltages that are positive with respect to $V_{IN–}$/Load. If the reference is set to +5V, the output is set near +5V with no input voltage and responds to input voltages that are negative with respect to $V_{IN–}$/Load.

In unidirectional applications that are configured to create a positive differential voltage across the device input pins with respect to the $V_{IN–}$ pin, both the reference pins can be tied to ground, as shown in Figure 10. This configuration results in an output set near to ground with no input voltage. Increasing the differential input voltage increases the output up from the near ground output level.

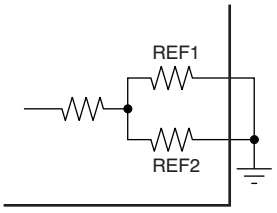

Figure 10. Unidirectional Mode: Positive Differential Voltage Configuration

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In applications that are configured to create a negative differential voltage across the device input pins with respect to the V_{IN-} pin, both the reference pins can be tied to the supply. This configuration, as Figure 11 illustrates, results in an output set near the supply voltage with no input voltage. Increasing the differential input voltage decreases the output down from near the supply voltage. It is important to note, though, that there is a limit to the level of supply voltage that is available when using this configuration. If this configuration is used, the supply voltage cannot be greater than 9V because 9V is the voltage limitation for the net reference voltage.

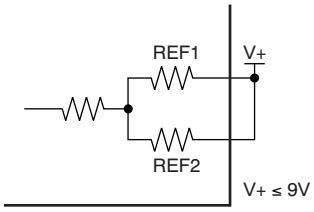

Figure 11. Unidirectional Mode: Negative Differential Voltage Configuration

4.2 Bi-directional Mode

Bi-directional refers to a load current that flows in both directions. Figure 2 shows I_S flowing in both directions. For bi-directional applications, the reference voltage can be set anywhere within the 0V to 5V range specified for the reference input. The voltage applied to the reference pin establishes the output voltage of the device with no input voltage. The output voltage is limited by the supply voltage, so there is a greater available range for positive input voltages than for negative voltages because the reference voltage is limited to the range of 0V to 5V.

The maximum range for the output of this device to accommodate a bi-directional application involves applying 5V to the reference pin and a supply voltage of 18V. This configuration allows for a maximum output voltage range of –4.96V/+12.6V about the 5V reference.

In bi-directional applications, the reference can be set to any voltage within the 0 and 9V range specified for the reference input. The voltage applied to the reference pin establishes the output of the device with no input voltage applied. With the output limited by the supply voltage and the reference voltage able to accommodate up to 9V, however, the reference voltage can be configured to give an equal positive and negative output range swing. The use of two reference pins allows for multiple configurations to achieve a desired output voltage range. The most common use of the two reference pin option is to tie one reference to the supply voltage and one pin to ground, as Figure 12 shows. The net equivalent of this configuration (based on the internal voltage divider) is a mid-supply reference voltage.

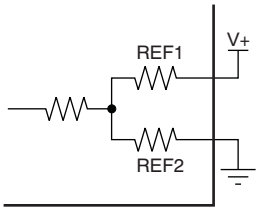

Figure 12. Bi-directional Mode: One Reference to Ground, One Reference to Supply Configuration

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If a specific voltage is required for the reference voltage, an external reference can be used, or a buffered voltage developed from a resistor divider could be used. Figure 13 and Figure 14 illustrate these two configurations, respectively.

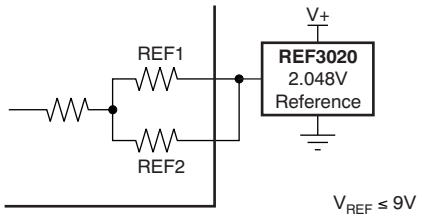

Figure 13. Bi-directional Mode: Specific Voltage Required Configuration

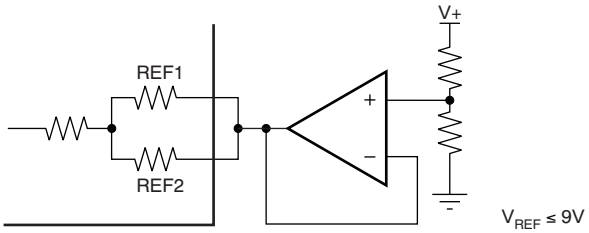

Figure 14. Bi-directional Mode: Buffered Voltage Configuration

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5 INA282-286EVM Schematic

5.1 Schematic

Figure 15 illustrates the INA282-286EVM schematic.

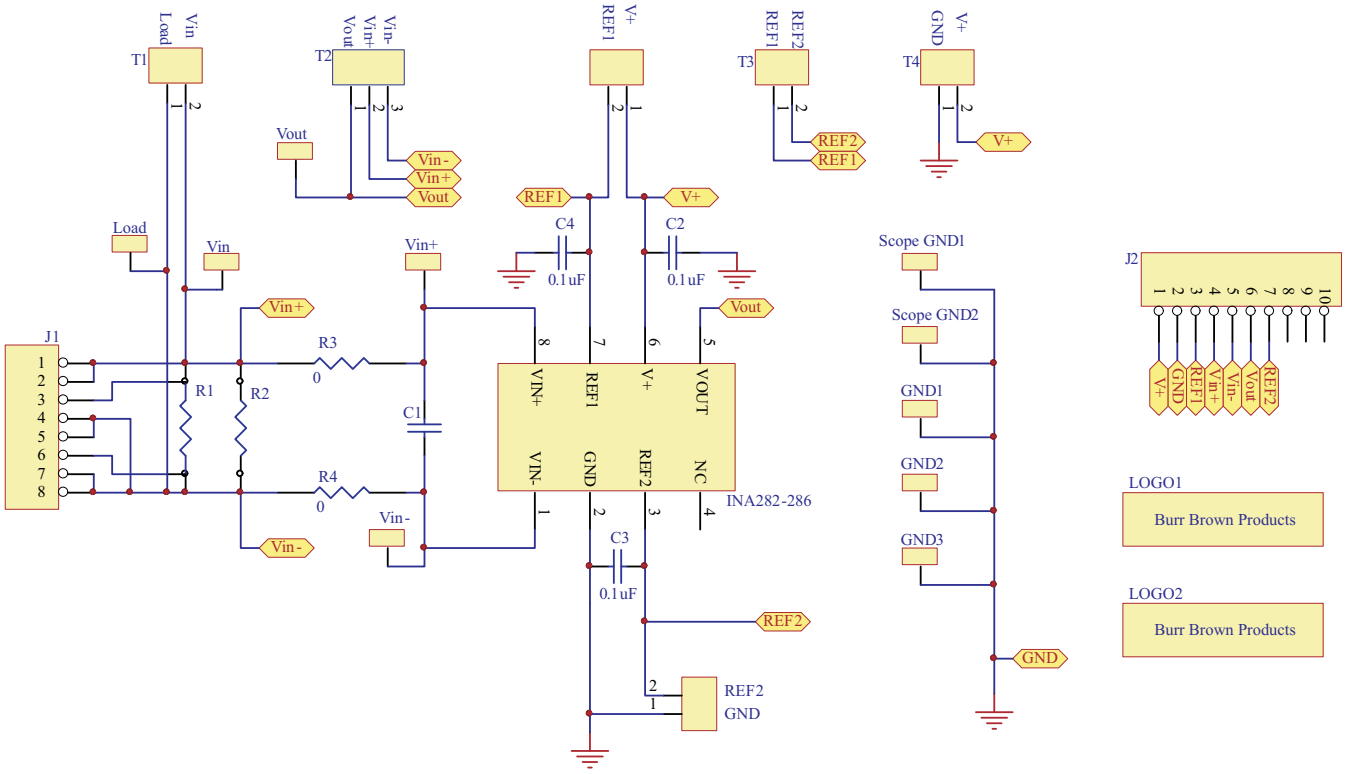

Figure 15. INA282-286EVM Schematic

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6 Bill of Materials

Table 2 provides the parts list for the INA282-286EVM.

Table 2. INA282-286EVM Bill of Materials

Count	RefDes	Value	Description	Manufacturer	Part Number
Optional/ Not Installed	R1	N/A			
Optional/ Not Installed	R2	N/A	Resistor, 0603-1206/Through-Hole		
2	R3, R4	0Ω	Resistor, 0Ω, 1/8W 5%, 0603-1206/Through-Hole	Panasonic - ECG	ERJ-6GEY0R00V
Optional/ Not Installed	C1	N/A	Capacitor, 0603-1206/Through-Hole		
3	C2, C3, C4	0.1µF	Capacitor, 0.1µF 50V X7R, 0603-1206/Through-Hole	Panasonic - ECG	ECJ-1VB1H104K
4	J1, J2, J3, J4	Strip cut to size	CONN HEADER 32POS .100" SGL GOLD	Samtec	TSW-132-07-G-S
11	All Test Points	TP cut to size	CONN HEADER 32POS .100" SGL GOLD	Samtec	TSW-132-07-G-S
8	None	N/A	CONN SOCKET RCPT .014-.026 30AU	AMP	5050863-5
4	None	N/A	Screw, Machine, Phillips, Panhead 4-40X1/4 SS	Building Fasteners	PMSSS 440 0025 PH
4	None	N/A	Standoffs, Hex , 4-40 Threaded, 0.500" length, 0.250" OD	Keystone Electronics	2203
5	INA282DIP-INA286DIP	N/A	Populated DIP-Adapter Board	Texas Instruments	
1	T2	N/A	3-Position Terminal Strip, Cage Clamp, 45°, 15A, Dove-tailed	On Shore Technology	ED300/3
3	T1, T3, T4	N/A	2-Position Terminal Strip, Cage Clamp, 45°, 15A, Dove-tailed	On Shore Technology	ED300/2

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EVM Warnings and Restrictions

It is important to operate this EVM within the input voltage range of of –14V to +80V; a supply voltage (Vs) range of +2.7V to +18V; and the output voltage range of GND + 0.05V to Vs – 0.4V.

Exceeding the specified input range may cause unexpected operation and/or irreversible damage to the EVM. If there are questions concerning the input range, please contact a TI field representative prior to connecting the input power.

Applying loads outside of the specified output range may result in unintended operation and/or possible permanent damage to the EVM. Please consult the EVM User's Guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative.

During normal operation, some circuit components may have case temperatures greater than +25°C. The EVM is designed to operate properly with certain components above +25°C as long as the input and output ranges are maintained. These components include but are not limited to linear regulators, switching transistors, pass transistors, and current sense resistors. These types of devices can be identified using the EVM schematic located in the EVM User's Guide. When placing measurement probes near these devices during operation, please be aware that these devices may be very warm to the touch.

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